7. POLICY

U.S. government policies are used to advance energy strategies such as energy security and environmental quality. In the case of renewable energy, and bioenergy in particular, a variety of policies have been implemented—research, development, and demonstration of new technologies, financial incentives, and regulatory mandates—to advance the use of renewables in the energy marketplace and thus realize the benefits of renewable energy. Many of the benefits of renewable energy are not captured in the traditional marketplace economics. Government policies are a means of converting non-economic benefits to an economic basis, often referred to as "internalizing externalities." This may be accomplished by supporting the research, development, and demonstration of new technologies that are not funded by industry because of projected high costs or long development time lines. To facilitate the introduction and market penetration of renewable technologies, the government may establish financial incentives such as tax credits for new technology or additional taxes on existing technology to make the product economically competitive. The government may also mandate the use of renewable energy or products through regulatory actions that override market economics. A Renewable Portfolio Standard that requires a given percentage of renewable generation of electricity is an example of regulatory policy. This chapter briefly reviews the pertinent Federal government policies.

Research, Development and Demonstration/Deployment[1]

Biomass research, development, and demonstration/deployment (RD&D) power, heat, fuels, and chemicals has been the subject of United States government programs since the early 1970s. In 1972, the Research Applied to National Needs (RANN) Directorate of the National Science Foundation (NSF) held several workshops to define the Fuels from Biomass Program (Ward 1976). In parallel, the Department of Interior had several activities funding urban wastes and industry residues uses, including energy (Phillips 1998).

To frame biomass RD&D in the context of the 1970s, the Environmental Protection Agency was formed at the end of 1970:

> *As concern with the condition of our physical environment has intensified, it has become increasingly clear that we need to know more about the total environment--land, water, and air. It also has become increasingly clear that only by reorganizing our Federal efforts can we develop that knowledge, and effectively ensure the protection, development and enhancement of the total environment itself* (President Nixon on the establishment of the Agency).

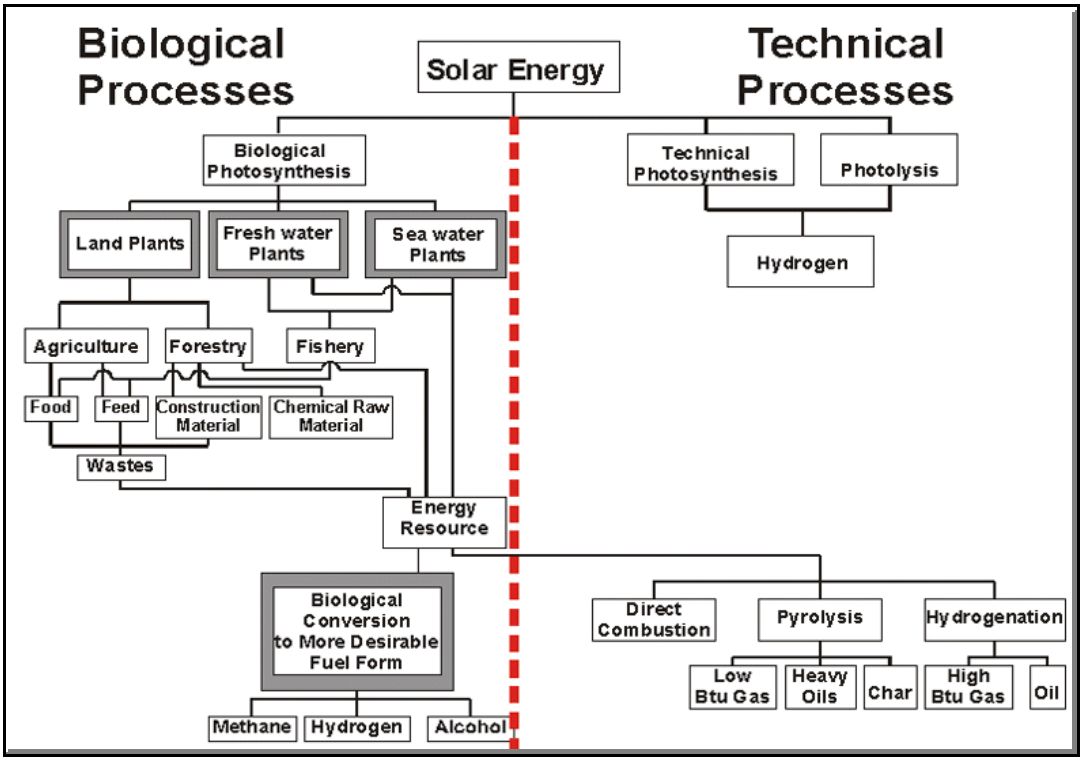
At that time, the United States had nearly 200 million inhabitants in 60 million households. Schools had no computers. Each person generated more than 1.5 kg of MSW per day in the United States. Paper companies recycled less than 20% of their fiber. Each person used about 350 GJ y^{-1}; and each dollar of the US GDP required 18 MJ of energy. Vehicles had an average fuel economy of less than 15.7 L per 100 km (15 miles/gallon), and the disposable income used to purchase motor fuels was about 4%.

Households spent half of that amount to purchase electricity. A trillion vehicle miles were traveled in the United States in that year (NSTC 1995).

[1] Excerpted from Chum, H.C. and R.P. Overend (2002?) "Biomass and Bioenergy in the United States," Advances in Solar Energy, Volume 15

The oil embargo and related crises of the 1970s brought urgency to solve energy and security issues. A series of changes in government structure gave energy higher importance and consolidated activities that were previously conducted by a number of agencies. The NSF's RANN research activities were transferred to the Federal Energy Administration. In Fiscal Year 1974, a comprehensive 5-year plan, "Fuels from Biomass Energy Program," was developed as part of the Project Independence Blueprint. The early vision, Figure 7.1, presented by Martin Wolf at a Congressional hearing on bioconversion, guided much of the subsequent developments (Wolf 1974). In 1975, biomass energy activities were transferred to the Energy Research and Development Authority (ERDA). The Fuels from Biomass program at ERDA was funded at $600,000 in 1975. Urban waste activities were transferred from the Department of Interior and funded at the level of $400,000. The total funding for these activities corresponds to $3 million in constant 1999$ (we will mainly use year 1999$ and 2000$ to express the expenditures in constant dollars, through a calculation using the GDP deflator).

Figure 7.1: The Bioenergy "Vision" in 1974



By 1977, all energy RD&D activities were consolidated in a new cabinet, the U.S. Department of Energy (USDOE). This department had then, and has now, multiple missions, including energy, energy security, defense-related activities such as nuclear weapons development and production, their safety and security, and advancement of the related science and technology (USDOE 2001).

Biomass and bioenergy funding from the USDOE can be framed in the context of the overall energy RD&D appropriations since 1978. A comparison of the major energy producing expenditures is shown in Figure 7.2, where funding for each of the technologies is in the order: nuclear>>coal>renewables >>oil, gas, and shale. Renewable RD&D investments over this period have been one-quarter to one-third of those in the nuclear area. Within the renewable energy technologies Figure 7.3, biomass and biofuels represent 12% of the overall investment (1978-2000) or $1.2 billion (2000$). Additional biomass

investments are found in the industrial activities funded under energy efficiency such as pulp and paper, agriculture, alternative feedstocks to chemicals, etc., as shown in Figure 7.4; energy efficiency activities in transportation, buildings, industry, and the Federal Energy Management Program (FEMP) are also included. For comparison, Figure 7.5 shows related investments in major fossil energy and component areas.

Figure 7.2: United States Appropriations for Energy R&D 1978 - 1998

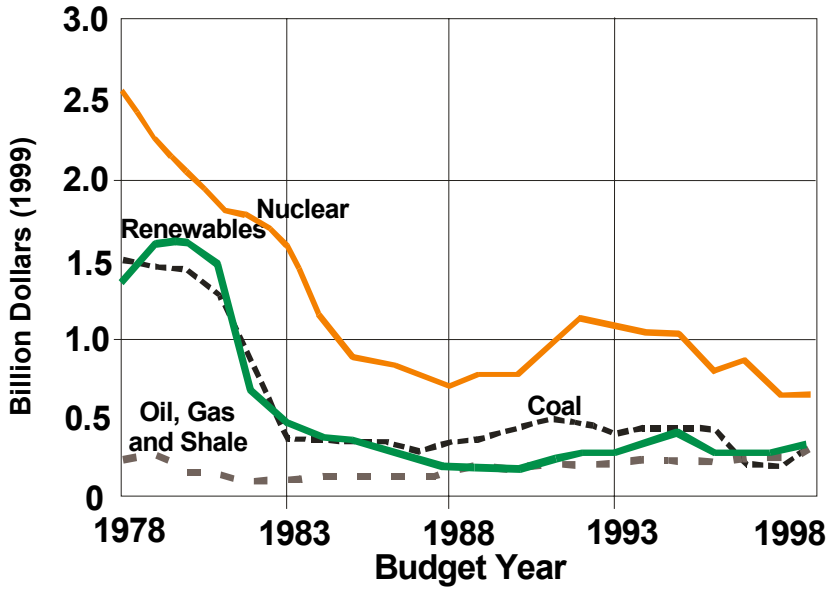


Figure 7.3: United States Appropriations for Renewable Energy R&D 1978 - 1998

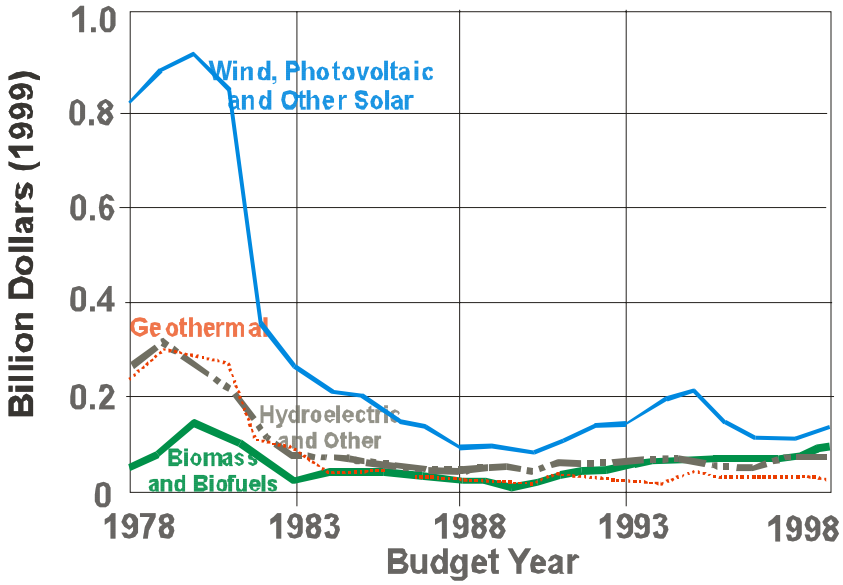


Figure 7.4: United States Appropriations for Energy Efficiency R&D 1978 - 1998

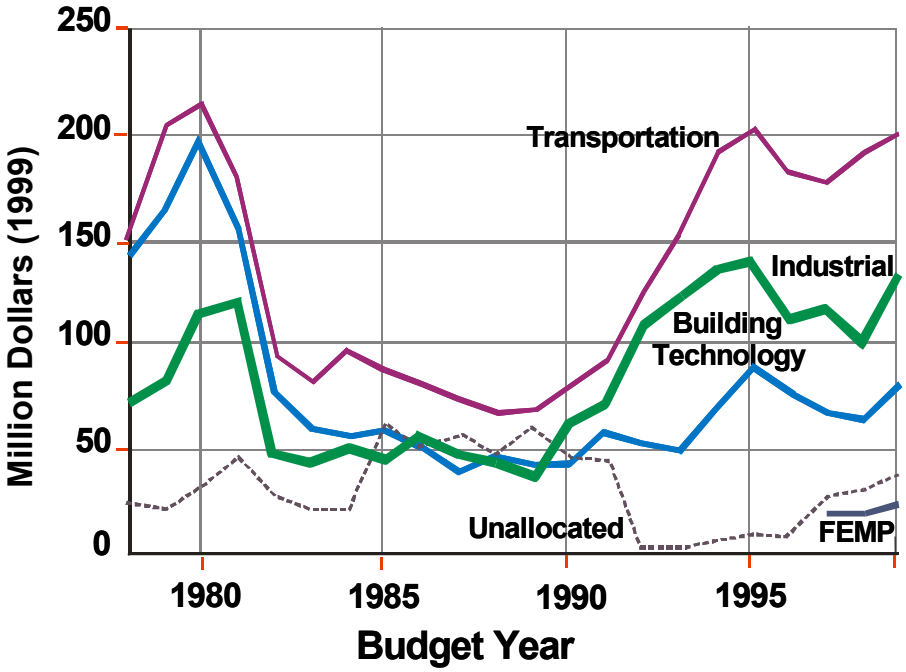
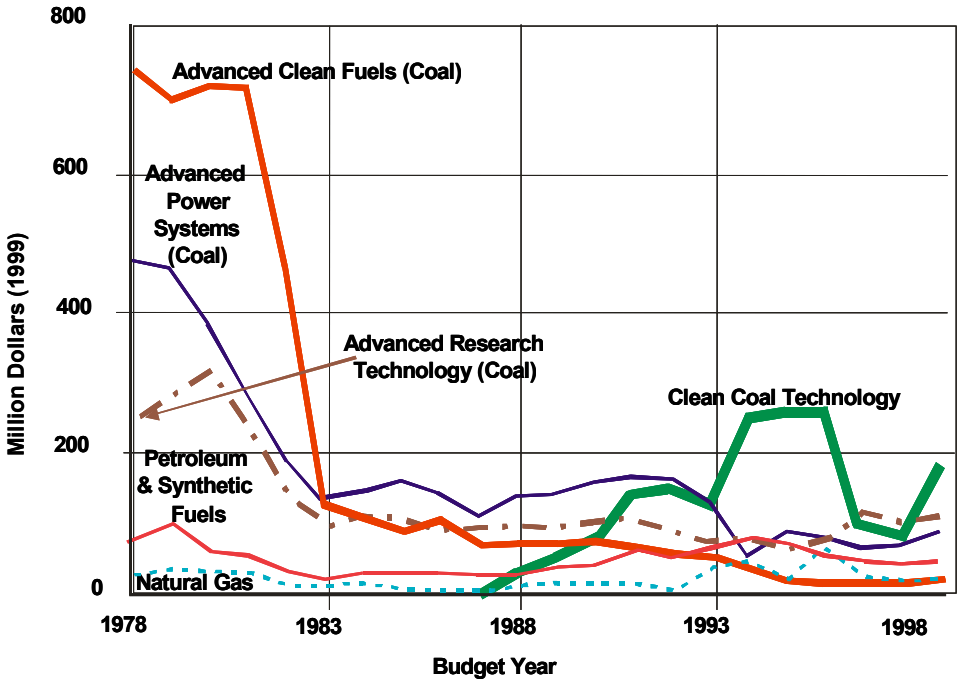


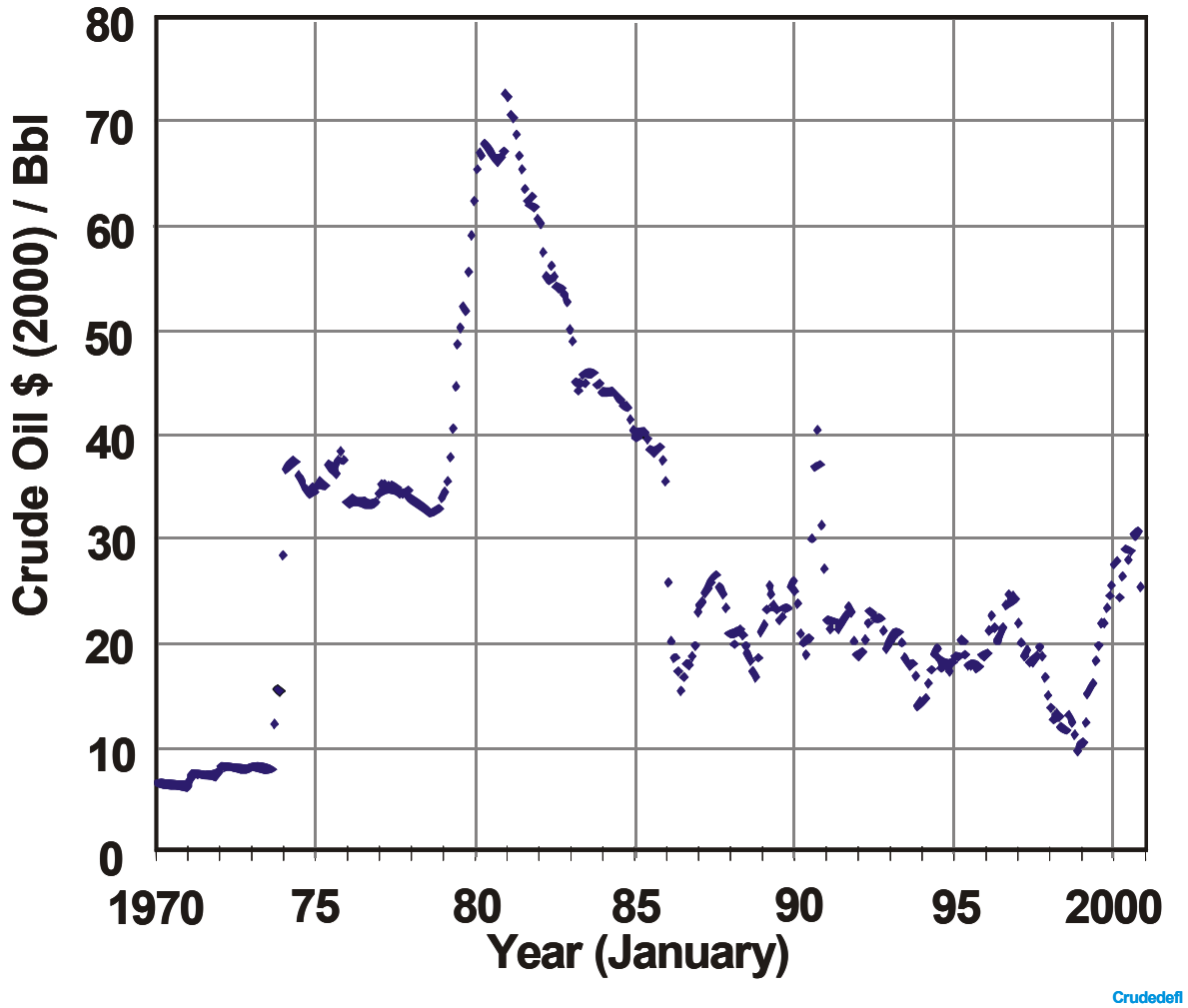
Figure 7.5: United States Appropriations for Fossil Energy R&D 1978 - 1998



The total investment in this period for all biomass and bioenergy expenditures, including urban waste energy and management and related energy efficiency activities, is $1.4-1.5 billion (2000$), or 14%-15% of total Federal energy RD&D expenditures. Funding for non-RD&D activities is not included (EIA 1999; EIA 2000).

Government actions to increase biomass use for energy varied significantly over the past 25 years. Many of these actions responded to crude oil price signals, as shown in Figure 7.6 in constant 2000 $. In 1977-1983, the goal was primarily to reduce the dependence of the United States on energy imports—mainly oil. The programs focused on the development of alternative fuels and activities included RD&D from exploratory to pioneer plants for a wide range of technology options. Significant outreach activities helped increase the energy self-sufficiency of the existing biomass industry and speed the replacement of some oil applications with biomass, e.g., home heating.

Figure 7.6: Crude Oil Prices 1970 – 2000 in 2000$



During 1977-1983, a technology-driven RD&D approach responded to the wide diversity of biomass resources and product possibilities, including a range of gaseous, liquid, and solid fuels, power, heat, value added products, and the use of many different biomass sources. The biomass resources included agricultural and forestry residues, urban wastes, and dedicated feedstocks to be produced on land or

water. Freshwater and seawater plants were considered for their biomass as well as for the direct production of hydrogen fuel from sunlight and water. Deployment was fostered in many ways, including studies facilitating the construction of commercial plants to produce alternative fuels—mainly ethanol. A few of the late 1970s technologies were advanced sufficiently to become commercially viable. Direct combustion improvements were implemented in areas such as the forest products industry, pulp and paper mills, and home heating equipment.

In the period 1983-1990, there was a marked change in the approach of the Federal government towards energy supply. Supply and demand imbalances were to be resolved by market forces and supporting federal government policies, many of which were also applied at state and local levels. This alignment amplified federal actions and afforded significant penetration of several renewable technologies and, in particular, biomass combustion and ethanol from corn starch. RD&D continued to develop technologies to expand supply and reduce demand through increased efficiency RD&D. The priority of government funding was to conduct long-term high-risk R&D. Companies could not be expected to carry out such R&D because the benefits were not immediate nor could the benefits be captured by individual firms. The focus on the production of liquid fuels and energy from municipal waste was maintained, though other ways to recover resources and safely manage solid waste were investigated.

The 1990s saw the U.S. federal government increase renewable energy and energy efficiency RD&D as a priority. Cost-shared RD&D was conducted through a wide range of public-private partnerships in defined sectors—power, transportation fuels, forest products, and agriculture. Government sponsored some outreach activities and the development of selected pioneer plants for new biomass technologies. The overall approach combined market forces with technology development. The focus was specific products—electricity, ethanol from lignocellulosic biomass, biodiesel, specific model terrestrial feedstocks, and efforts to make energy and value-added products from biomass. In addition, RD&D in the forest products and agricultures sectors was reconfigured. Industry associations in these sectors developed Agenda 2020 visions and technology roadmaps to guide the selection of DOE efforts in this area (Agenda 2020, Agriculture Vision 2020 Anon 1998 and 1999).

A baseline (essentially a single snapshot) inventory of the overall government funding for bioenergy and biobased products for the United States federal government was prepared for fiscal year 1998 (Chum, Elam et al. 2000) . In that year the U.S. federal government invested $253 million in RD&D activities, including investments in basic research at the DOE Office of Science and at the Ntional Science Foundation. Of the $253 million, $153 million were devoted to bioenergy. Approximately 90% of the total bioenergy and biobased products amount, nearly $230 million (2000$), was appropriated through DOE and USDA programs. Other agencies—the NSF, EPA, and the Department of Commerce (Advanced Technology Program)—funded specific activities in support of these areas.

In fiscal year 2001, the government investment in RD&D at DOE and USDA was $239 million. The total R&D investment level by these two departments was similar to the previous numbers, but there were major changes in emphasis and scope. These totals do not include R&D investments at the NSF on the Plant Genome Research Program. The NSF plant genome activities began in 1998, and a portion of the $25 million annual budget is certainly applicable to biomass activities. The NSF also funds bioprocessing, metabolic engineering, separations technologies, fermentation and enzyme-catalyzed systems, chemistry, materials, and engineering programs, which include biobased products and bioenergy. In fiscal year 2001, the EPA invested $7 million in biomass-related activities, according to a report to Congress on Biomass Research and Development Act of 2000 (USDA/USDOE 2001).

Throughout these 25 years, funding for specific bioenergy areas was discontinued while focusing on specific products. Market and business considerations, funding availability, policy changes (e.g., deregulation of the electricity sector), and Congressional directions on specific projects to fund all played

a role in the process of selecting areas to be maintained or discontinued. For example, the efforts in high-pressure liquefaction to produce oil replacements did not reach product quality or cost effectiveness goals and was terminated in 1983. Macroalgae sometimes known as giant kelp were explored in several concepts but they were not cost effective in light of the declining oil price trend of that period. Similarly, during the "lean funding years" of the mid-to late-1980s, when the United States was in the process of balancing its budget, discretionary spending was significantly curtailed and much of the R&D in thermochemical fuels was discontinued in favor of ethanol from lignocellulosic biomass, which became, respectively, the fuel and feedstock of choice. All thermochemical fuels activities including methanol, other transportation fuels, or thermal depolymerization concepts that could have led to multiple products (1988-1989) were discontinued. By 1993, investigations on microalgae accumulating large fractions of their body mass as lipids were also discontinued primarily because of difficulties reaching cost effectiveness. Finally, towards the mid-1990s, the programs on wastes-to-energy or products from a wide range of "wastes" (municipal, urban, industrial, and agricultural) were also discontinued.

Incentives[2]

The major Federal legislation on financial incentives for renewable energy and renewable transportation fuels has been structured as tax credits and production incentive payments. See Tables 7.1 and 7.2 for a summary of major Federal provisions that affect renewable energy and renewable-based transportation fuels, respectively. For renewable energy, tax credits for purchases of renewable energy equipment were aimed at both the residential and business sectors. Accelerated depreciation of renewable energy equipment and production incentives were aimed at investors. From 1978 through 1998, similar types of tax credits have been in existence. Over time, the various laws have usually expanded the technologies covered, increased the credit amount, or extended the time period.

Two new types of financial incentives were introduced as part of the Energy Policy Act of 1992 (EPACT)—a production tax credit (PTC) and a renewable energy production incentive (REPI). The PTC is a 1.5 cents-per- kilowatthour (kWh) payment, payable for 10 years, to private investors as well as to investor-owned electric utilities for electricity from wind and closed-loop biomass facilities. The PTC is also known as the Section 45 tax credit, and was modified in 1999 to include chicken litter as well as closed-loop biomass. Closed-loop biomass is defined as biomass grown and harvested specifically for energy purposes. As far as is known today, no organization has applied for the PTC for closed-loop biomass. The REPI provides a 1.5 cents-per-kWh incentive, subject to annual congressional appropriations for generation from biomass (except municipal solid waste), geothermal (except dry steam), wind and solar from tax-exempt publicly owned utilities, local and county governments, and rural cooperatives.

For renewable transportation fuels, tax credits and tax exemptions are used to promote the use of renewable fuels, with the goal of displacing petroleum use in the transportation sector. There are four Federal tax subsidies for the production and use of alcohol transportation fuels: (1) a 5.4-cents-per-gallon excise tax exemption, (2) a 54-cents-per-gallon blender's tax credit, (3) a 10-cents-per-gallon small ethanol production tax credit, and (4) the alternative fuels production tax.

However, only the partial exemption from motor fuels excise tax is used to any extent. It is important to note that there are important financial incentive issues in the form of tax equity regarding all of the

[2] Excerpted from: Gielecki, M. Mayes, F. and L. Prete "Incentives, Mandates, and Government Programs for Promoting Renewable Energy," USDOE Energy Information Agency, http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/incent.html, 4/18/2002

"alternate transportation fuels." However, only the alcohol fuels are renewable, so this discussion is confined to those. The primary incentive is the ethanol excise tax exemption.

Table 7.1: Time Line - Major Tax Provisions Affecting Renewable Energy

1978	**Energy Tax Act of 1978** (ETA) (P.L.95-618) Residential energy (income) tax credits for solar and wind energy equipment expenditures: 30 percent of the first $2,000 and 20 percent of the next $8,000. Business energy tax credit: 10 percent for investments in solar, wind, geothermal, and ocean thermal technologies; (in addition to standard 10 percent investment tax credit available on all types of equipment, except for property which also served as structural components, such as some types of solar collectors, e.g., roof panels). In sum, investors were eligible to receive income tax credits of up to 25 percent of the cost of the technology. Percentage depletion for geothermal deposits: depletion allowance rate of 22 percent for 1978-1980 and 15 percent after 1983.
1980	**Crude Oil Windfall Profits Tax Act of 1980** (WPT) (P.L.96-223) Increased the ETA residential energy tax credits for solar, wind, and geothermal technologies from 30 percent to 40 percent of the first $10,000 in expenditures. Increased the ETA business energy tax credit for solar, wind, geothermal, and ocean thermal technologies from 10 percent to 15 percent, and extended the credits from December 1982 to December 1985. Expanded and liberalized the tax credit for equipment that either converted biomass into a synthetic fuel, burned the synthetic fuel, or used the biomass as a fuel. Allowed tax-exempt interest on industrial development bonds for the development of solid waste to energy (WTE) producing facilities, for hydroelectric facilities, and for facilities for producing renewable energy.
1981	**Economic Recovery Tax Act of 1981** (ERTA) (P.L.97-34) Allowed accelerated depreciation of capital (five years for most renewable energy-related equipment), known as the Accelerated Cost Recovery System (ACRS); public utility property was not eligible. Provided for a 25 percent tax credit against the income tax for incremental expenditures on research and development (R&D).
1982	**Tax Equity and Fiscal Responsibility Act of 1982** (TEFRA) (P.L.97-248) Canceled further accelerations in ACRS mandated by ERTA, and provided for a basis adjustment provision which reduced the cost basis for purposes of ACRS by the full amount of any regular tax credits, energy tax credit, rehabilitation tax credit.
1982-1985	**Termination of Energy Tax Credits** In December 1982, the 1978 ETA energy tax credits terminated for the following categories of non-renewable energy property: alternative energy property such as synfuels equipment and recycling equipment; equipment for producing gas from geopressurized brine; shale oil equipment; and cogeneration equipment. The remaining energy tax credits, extended by the WPT, terminated on December 31, 1985.

1986	**Tax Reform Act of 1986** (P.L.99-514) Repealed the standard 10 percent investment tax credit. Eliminated the tax-free status of municipal solid waste (MSW) powerplants (WTE) financed with industrial development bonds, reduced accelerated depreciation, and eliminated the 10 percent tax credit (P.L.96-223). Extended the WPT business energy tax credit for solar property through 1988 at the rates of 15 percent for 1986, 12 percent for 1987, and 10 percent for 1988; for geothermal property through 1988 at the rates of 15 percent for 1986, and 10 percent for 1987 and 1988; for ocean thermal property through 1988 at the rate of 15 percent; and for biomass property through 1987 at the rates of 15 percent for 1986, and 10 percent for 1987. (The business energy tax credit for wind systems was not extended and, consequently, expired on December 31, 1985.) Public utility property became eligible for accelerated depreciation.
1992	**Energy Policy Act of 1992** (EPACT) (P.L.102-486) Established a permanent 10 percent business energy tax credit for investments in solar and geothermal equipment. Established a 10-year, 1.5 cents per kilowatthour (kWh) production tax credit (PTC) for privately owned as well as investor-owned wind projects and biomass plants using dedicated crops (closed-loop) brought on-line between 1994 and 1993, respectively, and June 30, 1999. Instituted the Renewable Energy Production Incentive (REPI), which provides 1.5 cents per kWh incentive, subject to annual congressional appropriations (section 1212), for generation from biomass (except municipal solid waste), geothermal (except dry steam), wind and solar from tax exempt publicly owned utilities and rural cooperatives. Indefinitely extended the 10 percent business energy tax credit for solar and geothermal projects.
1999	**Tax Relief Extension Act of 1999** (P.L. 106-170) Extends and modifies the production tax credit (PTC in EPACT) for electricity produced by wind and closed-loop biomass facilities. The tax credit is expanded to include poultry waste facilities, including those that are government-owned . All three types of facilities are qualified if placed in service before January 1, 2002. Poultry waste facilities must have been in service after 1999. A nonrefundable tax credit of 20 percent is available for incremental research expenses paid or incurred in a trade or business.
Notes: The residential energy credit provided a credit (offset) against tax due for a portion of taxpayer expenditures for energy conservation and renewable energy sources. The general business credit is a limited non-refundable credit (offset) against income tax that is claimed after all other non-refundable credits.	

Table 2. Timeline - Major Tax Provisions Affecting Renewable Transportation Fuels	
1978	**Energy Tax Act of 1978** (ETA) (P.L.95-618) Excise tax exemption through 1984 for alcohol fuels (methanol and ethanol): exemption of 4 cents per gallon (the full value of the excise tax at that time) of the Federal excise tax on "gasohol" (gasoline or other motor fuels that were at least 10 percent alcohol (methanol and ethanol))
1980	**Crude Oil Windfall Profits Tax Act of 1980** (WPT) (P.L.96-223) Extended the gasohol excise tax exemption from October 1, 1984, to December 31, 1992. Introduced the alternative fuels production tax credit. The credit of $3 per barrel equivalent is indexed to inflation using 1979 as the base year, and is applicable only if the real price of oil is bellow $27.50 per barrel. The credit is available for fuel produced and sold from facilities placed in service between 1979 and 1990. The fuel must be sold before 2001. Introduced the alcohol fuel blenders' tax credit; available to the blender in the case of blended fuels and to the user or retail seller in the case of straight alcohol fuels. This credit of 40 cents per gallon for alcohol of at least 190 proof and 45 cents per gallon for alcohol of at least 150 proof but less that 190 proof was available through December 31, 1992. Extended the ETA gasohol excise tax exemption through 1992. Tax-exempt interest on industrial development bonds for the development of alcohol fuels produced from biomass, solid waste to energy producing facilities, for hydroelectric facilities, and for facilities for producing renewable energy.
1982	**Surface Transportation Assistance Act** (STA) (P.L. 97-424) Raised the gasoline excise tax from 4 cents per gallon to 9 cents per gallon, and increased the ETA gasohol excise tax exemption from 4 cents per gallon to 5 cents per gallon. Provided a full excise tax exemption of 9 cents per gallon for "neat" alcohol fuels (fuels having an 85 percent or higher alcohol content).
1984	**Deficit Reduction Act of 1984** (P.L.98-369) The STA excise tax exemption for gasohol was raised from 5 cents per gallon to 6 cents per gallon. Provided a new exemption of 4.5 cents per gallon for alcohol fuels derived from natural gas. The alcohol fuels "blenders" credit was increased from 40 cents to 60 cents per gallon of blend for 190 proof alcohol. The duty on alcohol imported for use as a fuel was increased from 50 cents to 60 cents per gallon
1986	**Tax Reform Act of 1986** (P.L.99-514) Reduced the tax exemption for "neat" alcohol fuels (at least 85 percent alcohol) from 9 cents to 6 cents per gallon. Permitted alcohol imported from certain Caribbean countries to enter free of the 60 cents per gallon duty.

	Repealed the tax-exempt financing provision for alcohol-producing facilities.
1990	**Omnibus Budget Reconciliation Act of 1990** (P.L. 101-508) Allows ethanol producers a 10 cent per gallon tax credit for up to 15 million gallons of ethanol produced annually. Reduced the STA gasohol excise tax exemption to 5.4 cents per gallon.
1992	**Energy Policy Act of 1992 (EPACT)** (P.L. 102-486) Provides: (1) a tax credit (variable by gross vehicle weight) for dedicated alcohol-fueled vehicles; (2) a limited tax credit for alcohol dual-fueled vehicles; and (3) a tax deduction for alcohol fuel dispensing equipment.
1998	**Energy Conservation Reauthorization Act of 1998** (ECRA) (P.L. 105-388) Amended EPACT to include a credit program for biodiesel use by establishing Biodiesel Fuel Use Credits. An EPACT-covered fleet can receive one credit for each 450 gallons of neat (100 percent) biodiesel purchased for use in vehicles weighing in excess of 8500 lbs (gross vehicle weight (GVW)). One credit is equivalent to one alternative fueled vehicle (AFV) acquisition. To qualify for the credit, the biodiesel must be used in biodiesel blends containing at least 20 percent biodiesel (B20) by volume. If B20 is used, 2,250 gallons must be purchased to receive one credit. **Transportation Equity Act for the 21st Century** (TEA-21) (P.L. 105-178) Maintains, through 2000, the 5.4 cent per gallon (of gasoline) excise tax exemption for fuel ethanol set by the Omnibus Budget Reconciliation Act of 1990 (P.L. 101-508). Extends the benefits through September 30, 2007, and December 31, 2007, but cuts the ethanol excise tax exemption to 5.3, 5.2, and 5.1 cents for 2001-2002, 2003-2004, and 2005-2007, respectively, and the income tax credits by equivalent amounts. The exemption is eliminated entirely in 2008.

Regulatory

The Public Utility Regulatory Policies Act of 1978 (PURPA) was the most significant section of the National Energy Act in fostering the development of facilities to generate electricity from renewable energy sources. However, with the electric power industry challenging its legality and implementation issues, the broad application of PURPA did not occur until after the legality of PURPA was upheld in 1981. PURPA opened the door to competition in the U.S. electricity supply market by requiring utilities to buy electricity from qualifying facilities (QFs). QFs are defined as nonutility facilities that produce electric power using cogeneration technology, or power plants no greater than 80 megawatts of capacity that use renewable energy sources. There is no size restriction for cogeneration plants; however, at least 5 percent of the energy output from a qualifying cogeneration facility must be dedicated to "useful" thermal applications.

Under PURPA, utilities are required to purchase electricity from QFs at the utilities' "avoided cost." The Federal government, in formulating regulations, often delegates implementation to the States. This occurred with PURPA, as the Federal Energy Regulatory Commission (FERC) delegated the authority for the determination of avoided cost to the States. In several States including California, avoided cost purchase contracts were very favorable to non-utility generators. For example, between 1982 and 1988, Standard Offer 4 (SO4) contracts written in California allowed QFs to sell renewable energy under 15-to-30 year terms. The contract guarantees fixed payment rates (based on forecasted short-run avoided costs)

for up to 10 years if the QF has signed a contract for at least 20 years. After the 10 th year, energy prices moved to the short-run avoided cost of the purchasing utility. The 10-year provisions were tied to forecasts of increases in oil and gas prices, and were the basis for the fixed payments for the first ten years of the contracts. The forecasts were much higher than prices actually turned out to be. Therefore, a price and revenue drop occurred in the eleventh year when the fixed contract energy prices converted to variable prices (based on short-term avoided cost), greatly lessening the economic viability of affected projects.

This assessment of the effectiveness of PURPA is actually an assessment of PURPA in combination with various tax incentives in place between 1978 and 1998. Under PURPA, qualifying facilities (QF) not only sold electricity to electric utilities at the utility's avoided cost rates–these facilities were also granted tax benefits described in, which lowered their overall costs. PURPA's QF status applied to existing as well as new projects. Together, by year end 1998, existing and new projects totaled 12,658 megawatts of QF renewable capacity (Table 3). Of this, two-thirds (8,219 megawatts) of QF capacity was biomass. Some of these biomass QFs, however, were not "new" facilities, but rather had gone into commercial operation prior to PURPA. PURPA enabled these facilities to connect to the grid, if they chose to become QFs, and sell any generation beyond their own use at avoided cost rates.

Table 3. Nonutility Qualifying Facilities Using Renewable Resources as of December 31, 1998

Fuel Source	Nameplate Capacity (megawatts)	Gross Generation (thousand megawatthours)
Biomass	8,219	45,032
Geothermal	1,449	9,882
Hydroelectric[a]	1,263	5,756
Wind	1,373	2,568
Solar Thermal	340	876
Photovoltaic	14	11
Total Renewable QF	12,658	64,126
Total QF, All Sources	60,384	327,977
Total Nonutility, All Sources	98,085	421,364

[a]Conventional; excludes pumped storage.
Notes: Totals may not equal sum of components due to independent rounding.
Source: Form EIA-860B, "Annual Electric Generator Report - Nonutility

Two of the criteria for evaluating the effectiveness of incentives and mandates such as PURPA are renewable capacity and generation growth. The EIA began collecting data from nonutility companies in 1989 (Table 4), 11 years after the passage of PURPA. However, between 1989 and 1998, renewable capacity increased by 11.9 percent. At the national level, non-hydroelectric renewable generating capacity rose by 4,426 MW; the increase in hydroelectric capacity was 5,703 MW. Renewable generation rose by 22 percent (Table 5). Most of the increase in electricity generation from renewable energy is in the utility hydropower sector, including net imports. Nearly all of the increase in biomass, geothermal, solar, and wind generation occurred between 1989 and 1993. Non-hydro renewable generation, excluding imports, actually declined by more than 5 percent between 1993 and 1998, due primarily to California replacing Standard Offer 4 contract "avoided cost" provisions with competitive bidding mechanisms, and declining production at The Geysers geothermal plant. Also, in 1992, New York amended its Six-Cent Rule, which

established a 6-cents-per-kilowatt hour floor on avoided costs for projects less than 80 MW in size, such that it was not applicable to any future power purchase agreements.

Table 4. U.S. Electric Power Sector Net Summer Capability, 1989-1998 (Megawatts)

Source	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hydroelectric[a]	74,587	73,964	76,179	74,773	77,405	78,042	78,563	76,437	79,788	79,573
Geothermal	2,603	2,669	2,632	2,910	2,978	3,006	2,968	2,893	2,853	2,917
Biomass	7,840	8,796	9,627	9,701	10,045	10,465	10,280	10,557	10,535	10,266
Solar/PV	264	339	323	339	340	333	333	333	334	365
Wind	1,697	1,911	1,975	1,823	1,813	1,745	1,731	1,678	1,579	1,698
Total Renewables	**86,990**	**87,679**	**90,736**	**89,547**	**92,582**	**93,591**	**93,874**	**91,897**	**95,090**	**94,819**
Non Renewables	637,275	647,241	649,741	657,016	662,373	670,423	675,643	683,975	683,412	681,065
Total	**724,265**	**734,920**	**740,477**	**746,563**	**754,955**	**764,014**	**769,517**	**775,872**	**778,502**	**775,884**

[a]Conventional; excludes pumped storage.

Notes: Biomass capability does not include capability of plants where the Btu of the biomass consumed represents less than 50 percent of the Btu consumed from all energy sources. Totals may not equal sum of components due to independent rounding.

Sources: Energy Information Administration, Form EIA-860A, "Annual Electric Generator Report - Utility" and predecessor forms, and estimated data using Form EIA-860B, "Annual Electric Generator Report - Nonutility," and predecessor form.

Data on renewable capacity in California were available for years prior to 1989. These data, for 1980 through 1996 (Table 6), more clearly show the growth in renewable capacity owned by nonutilities since the passage of PURPA. Renewable-based nonutility capacity (excluding cogeneration) rose from 187

Table 5. California Nonutility Power Plants Installed Capacity, 1980-1996 (Megawatts)

Year	Cogeneration[a]	Waste-to-Energy[b]	Geothermal	Small Hydro	Solar	Wind	Total
1980	227	14	0	0	0	173	414
1981	261	14	0	0	0	176	451
1982	412	32	0	48	1	176	669
1983	658	46	9	59	8	227	1,007
1984	893	79	96	67	27	496	1,658
1985	1,444	140	178	107	57	1,015	2,941
1986	1,788	275	188	144	122	1,235	3,752
1987	3,063	396	319	176	155	1,366	5,475
1988	3,662	513	587	229	221	1,378	6,590
1989	4,942	783	806	298	301	1,382	8,512
1990	5,315	878	870	321	381	1,647	9,412
1991	5,838	883	813	330	374	1,698	9,936
1992	5,684	804	831	371	408	1,729	9,827
1993	5,778	845	863	370	373	1,797	10,026
1994	5,857	795	863	410	373	1,629	9,927
1995	6,280	709	846	349	368	1,630	10,182
1996	6,177	823	885	362	360	1,709	10,316

[a]Includes gas-fired facilities and biomass co-firing and cogeneration.

[b]Waste-to-Energy includes wood and wood waste, municipal solid waste, landfill gas, and other biomass. However, biomass co-firing and cogeneration capacity is included under cogeneration.

Source: California Energy Commission, Draft Final Report, *California Historical Energy Statistics*, January 1998, Publication Number: P300-98-001.

Notes: Data exlude facilities rated less than 5 megawatts. Some data in this table are inconsistent with national data in Table 4 due to different sources, categories, and coverage. Also, these data represent installed capacity, while the data in Table 4 represent net summer capability.

(Imports)	19,148,542	16,302,116	22,318,562	26,948,408	28,558,134	30,478,863	28,823,244	33,359,983	27,990,905	26,031,784
Conventional Hydroelectric (Exports)	5,464,824	7,543,487	3,138,562	3,254,289	3,938,973	2,806,712	3,059,261	2,336,340	6,790,778	6,158,582
Total Net Imports	**14,216,980**	**9,296,942**	**19,916,921**	**24,583,983**	**25,496,219**	**28,844,268**	**26,648,933**	**31,673,157**	**21,216,620**	**19,918,347**
Total Renewable Electricity Generation	**341,796,886**	**364,180,824**	**377,945,145**	**353,809,284**	**385,110,540**	**369,891,432**	**415,642,155**	**458,883,336**	**456,520,167**	**418,129,367**

Note: Totals may not equal sum of components due to independent rounding.

Sources: **Nonutility Sector - 1989-1997**: Energy Information Administration, Form EIA-867, "Annual Nonutility Power Producer Report." **Nonutility Sector - 1998**: Energy Information Administration, Form EIA-860B, "Annual Electric Generator Report - Nonutility." **Electric Utility Sector - 1989-1997**: Energy Information Administration, Form EIA-860, "Annual Electric Generator Report." **Electric Utility Sector- 1998**: Form EIA-860A "Annual Electric Generator Report - Utility." **Imports and Exports**: Energy Information Administration, *Renewable Energy Annual*, DOE/EIA-0603(95-99) (Washington, DC).

megawatts in 1980 to 3,777 megawatts (excluding small hydropower and cogeneration plants) in 1996.

Most of the growth had occurred by 1990. Between 1990 and 1993, California nonutility renewable capacity (excluding small hydropower and cogeneration plants) increased just 3% to 3,878 megawatts, and between 1993 and 1995, capacity actually dropped to 3,553 megawatts; generation followed a similar pattern. The principal reasons for this decline were the lower PURPA "avoided costs" when the long-term energy payment provisions of the contracts (usually 10-years), mostly signed in the early 1980s, expired. Natural gas prices in nominal dollars paid by electric utilities in California declines from a high of $6.77 per million Btu in 1982 to between $2.50 to $3.00 in 1986 through 1993. By 1995, the price declined further to $2.22.

This, along with the repeal of the standard investment tax credits in 1986, caused some wind, biomass, and solar facilities to reduce output or cease operation. Also, there was a substantial slowdown in the construction of new capacity. This slowdown transpired despite substantial decreases in short-run average costs of renewables because the operating costs were not reduced enough to be competitive in the market conditions of the mid-to-late 1990s.

Another criterion in evaluating the effectiveness of PURPA, in addition to expansion of renewable energy capacity and generation, is the cost competitiveness of the renewable facilities in the market. Utility wholesale power purchases from other utilities, which are more often made on a mutually agreeable economic basis between utilities and may be regarded as reflecting "wholesale" prices, averaged 3.53 cents per kWh nationwide in 1995. Although EIA has not attempted to estimate the cost of PURPA directly, it has examined the prices that utilities paid in 1995 to purchase power from nonutilities and, in particular, PURPA QF nonutilities using renewable resources. The average price utilities paid all nonutilities was 6.31 cents per kWh nationwide, considerably higher than the average wholesale price. Higher still was the price utilities paid nonutilities for renewable-based electricity. Utilities paid an average of 9.05 cents per kWh for nearly 42,800 million kWh of power from renewable QFs in 1995, compared with just 5.17 cents per kWh for 3,300 million kWh of power from non-QF renewables. This difference was even more extreme in California, where the renewable QF/non-QF purchased power costs were 12.79 and 3.33 cents per kWh, respectively. All non-QF purchases of renewable energy, however, were from hydropower facilities, the lowest cost renewable resource–and the lowest cost of all electricity resources. In analyzing these data, the reader should bear in mind that by 1995, many of the original PURPA power purchase contracts between utilities and nonutilities had expired. Therefore, the data reflect a mixture of the original avoided cost contracts and newer contracts.

Renewable-based generation costs would obviously have compared much more favorably with other generation costs during 2000, when California experienced severe electricity and natural gas shortages. Natural gas prices--the primary basis for determining alternative generation cost--rose sharply during 2000. Through September, the average cost of gas delivered to electric utilities in California increased to $4.32 per million Btu as compared to $2.68 for deliveries through September 1999.